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DECEMBER, 1958 VOLUME 20, No. 8

An Outdoor Laboratory
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Index for Volume 20

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Cover Photograph

A Philips electron microscope picture of the uniflagellate spore of an unnamed Actinoplanes–like microorganism. Photograph taken by Frederick Rothwell, former post doctoral fellow, Purdue University. Data: magnified 20,000X at 60 kilovolts w/chromium. The light patch above the spore and along the flagellum is an accumulation of chromium. The black markers to the left indicate one micron.

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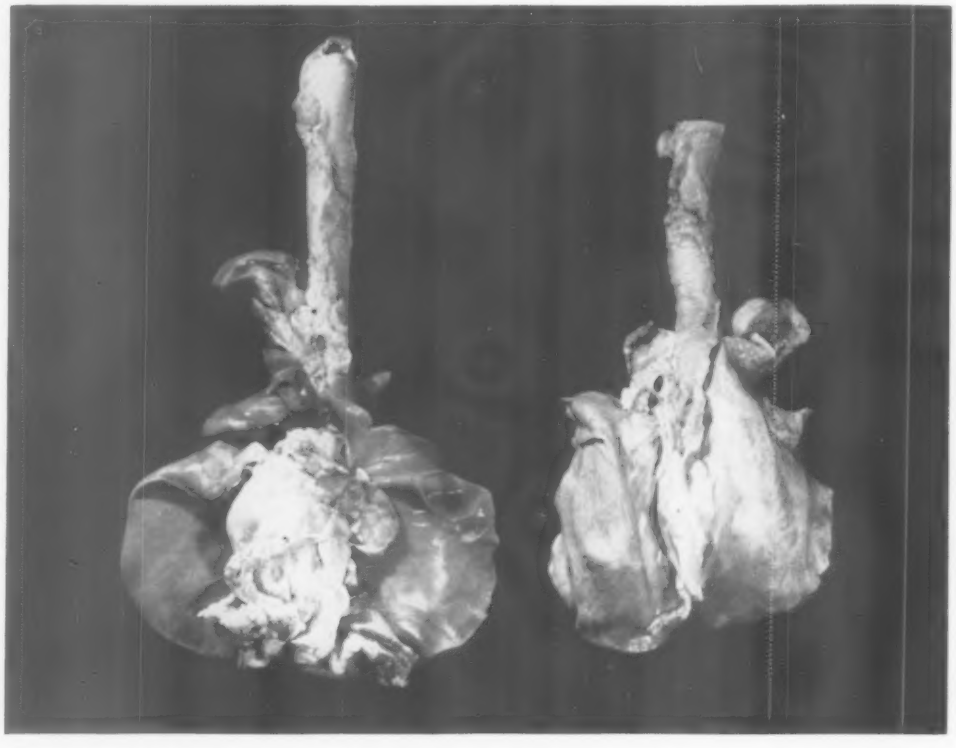

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Outdoor Laboratory Series Number 3

DEVELOPING AN OUTDOOR LABORATORY

HERBERT R. DRURY*

University of South Dakota, Vermilion, South Dakota

The Putney School, a private, secondary, co-educational institution is located above the Connecticut River valley near Brattleboro, Vermont. Approximately 185 students are enrolled, and all of them must participate in afternoon work job programs and specialized evening activities in addition to their academic studies. During 1956 this school purchased almost 50 acres of abandoned farm land, forest, meadow, and watercourse for the purpose of developing its own outdoor laboratory and nature study area. The plan was to create an educational experience in natural resources for the students by incorporating land use into classroom studies and into the physical work program. Attempts were made to pick those projects which would be most instructive and which would go farthest towards improving the land for wildlife and nature appreciation at a minimum of expense. Many of these ideas have been partially worked into the academic courses of biology, general science, and art, as well as into several of the unusual evening activities offered at the Putney School. Among them are mineralogy, meteorology, painting, natural history, and diorama building.

Each fall and spring semester since purchase of the "Garland Pond Area," as it was called, there have been crews of about a dozen students each working on this land under supervision of the school biology teacher in the routine "work job" requirement. These groups generally toiled an hour and a half for three afternoons a week and took part in regular sports the other days. Student crew heads directed operations once weekly during faculty meetings and usually followed suggestions of the adult leader. It was largely up to the faculty advisor to indicate what might be done, but students often attempted projects of their own when approved. Tools and labor were plentiful, therefore extra funds for this particular program have not been needed to date.

Because the biology teacher was new to the school, relatively little attempt was made to integrate classwork into this land management scheme during the first year. Many of the early efforts were experiments in learning to make effective use of students and in discovering how young people would react to this kind of teaching. Most of the activity, therefore, was confined to physical improvements by the work crews, and to reconnaissance of the needs, values, and potentialities of the land. Occasionally an informal class was held on the job to explain why certain work needed to be done and what benefits could be expected therefrom. Also, in order to inform the entire school body of the need for conservation by everyone, a movie on the subject was shown in assembly early in the year.[1] Several students then described their conservation accomplishments on the "Garland Pond Wildlife Area" to the school student body.

Although several projects had already been completed outside the classroom, it was during the second year that real progress was made in both land improvements and in teaching–learning experiences out of doors. Many individual, and at least three group efforts, centering upon this property were undertaken by students in academic courses and even in non-academic evening activities. People with artistic talent sketched or painted trees, flowers, habitats and conservation practices which they observed at the Garland Pond area during regular school terms or as part of semi-annual ten day "Project Weeks." Other people collected, preserved, identified or labelled many of the plants and insects on or from this tract.

Ecological studies of the habitats and environmental associations were also made and recorded on small maps. A large scale map

[1] "The River," directed by Pare Lorentz, Farm Security Administration, USDA 1937, sound, B&W, 32 mins. (1939 version).

with suitable grid pattern for locating points more exactly is needed, however, before any details can be accurately plotted. The making of such a map has been undertaken by part of the Putney School Work Camp crews for the past two summers. They have used a surveyor's transit several full afternoons weekly and have marked a major portion of the land with yellow stakes placed at regular intervals preliminary to establishing contours. As part of conservation studies for biology classes, some students also have built stream improvement structures on the inlets to Garland Pond, kept photographic records of vegetation, or laid out nature trails.

Photographs of accomplishments and progress in the area have also been made by the teacher, but students are now taking over this phase of the work. It is expected that they will continue to take pictures at specified photographic sites, already marked with painted stakes and tags, so that annual changes in vegetation, whether natural or man-made, can be permanently recorded. Unfortunately, not all projects have been entirely successful, the photographs in particular falling short of expectations because of faulty film.

Two "evening activities" were based, at least in part, on natural resources of the newly acquired acreage. The first of these was a "course" in the building of museum-type dioramas or other exhibits depicting local aspects of biology, conservation, and natural history. The second was actually a part of the first, and consisted in doing research in connection with the exhibits, as well as preparing separate projects more or less related to natural history. This combined activity was directed by the biology teacher and Mr. George Frederick Mason, formerly chief diorama builder at the American Museum of Natural History for 25 years. His knowledge of this craft and of nature's wonders (he has written seven books on animals)[1] was most helpful in planning wildlife area work and in the construction of a real life diorama of an under water scene at Garland Pond. Animal specimens were infiltrated with paraffin, while plants were specially preserved or made of paper and wire for this exhibit. The natural history students wrote up life habits of the animals and drew an outline sketch as a key to their locations within the diorama. Species shown included blacknosed dace, "pollywogs," diving beetles, water scorpions, dragonfly nymphs, caddis fly larvae, an adult leopard frog, and others. Some of the researchers also helped on the construction work, and vice versa, so that most students in the diorama-natural history activity learned something of both phases of this work while using examples from the Garland Pond outdoor laboratory.

These are just a few of the classroom teaching activities that have evolved from the Garland Pond idea, but for the interest of teachers working on similar developments elsewhere, the following is a more complete list of projects undertaken mostly by student work job crews. First, the pupils cut or cleared old roads and new trails for access to all parts of the area, then cleaned up eyesores and pruned or released apple trees. Following this, they cut clearings in an area of second growth white pine to encourage greater light penetration and a diversity of undergrowth for wildlife. All cuttings were collected and heaped into brush piles or wildlife shelters. Students also removed old fences and built new ones for an emergency horse pasture in hopes that limited grazing would keep at least this one area from reverting to forest by natural succession. Later they planted two hundred Red (Norway) Pine seedlings and many confirmed wildlife food shrubs such as Multi-flora Rose, Tatarian Honeysuckle, Silky Cornel, Toringo Crabapple, Autumn Olive, and others. These workers also planted cuttings and seeds of decorative or useful flowers, trees, and shrubs along field borders, hedgerows, vacant fence lines, and in odd corners. Included among this flora were bloodroot, forsythia, maple, oak, spruce, and willow of various types.

A small nursery was also established elsewhere on school property, and protected from wildlife, where more of these same and other plants were started for transplanting to the area when of sufficient size to withstand browsing. In addition, several water holes were dug in wet spots, and one of these proved to be a spring that overflowed even through the local drought of 1957. They have been very handy for wetting down new plantings.

[1]Publ. by Morrow, N. Y., *Animal Tracks; Homes; Clothing; Tools; Sounds; Weapons;* and the most recent: *Animal Trails.*

FIG. 1. Putney School students planting trees and shrubs beside entrance to the school's new outdoor laboratory during afternoon "Work Jobs."

Another project was to re-establish Garland Pond as a wildlife haunt similar to what it had been some twenty years ago when the original wooden dam was constructed. Where water had once lain twelve feet deep and had reportedly produced enormous trout, there was only silt, mud, and grass overlying a sagging dam. A shallow pool of muddy water covering but a fraction of the original surface area was all that remained of the late George Garland's once fine pond. So the dam was torn open, the flood gates pulled, and the silt partly washed away as a result of Putney student efforts. Crew members shoveled debris into the escaping water and encouraged erosion of the muck by temporary diversion structures during high water.

The original depth has thus been restored over perhaps a tenth of the area already, and it is hoped that nature will complete the job with a little help from school crews over the next few years. Should this method prove to be too slow, drag lines or explosives can be employed to complete the silt removal. Also there is special lumber already on hand, and about the only thing actually purchased for this entire project, for eventual replanking of the dam. It is hoped that some deep water areas can be maintained near the spillways in addition to large amounts of shallow water around the margin of the pond where waterfowl foods can be planted. Muskrats, trout, and wildfowl already visit the marsh, and it is hoped that more can be carried as residents when conditions are improved.

Other accomplishments of the students include the building of log bridges and steps, small log and stone dams, and erosion control drainage ditches.[1]

FIG. 2. "Wildlife Crew" members and biology students diverting flood waters to accelerate erosion of silt from former Garland Pond. Entire scene was once flooded to depths of ten feet and more. Note dam, lower right.

Proposals for the future include rejuvenation of the pond-marsh, further stream improvements and forest clearings, forest improvement cutting and pruning, experimental wildlife food plantings, pasture and water hole completion, marking and identification of flora, ecological studies, boundary markers, fish stocking, maps, signs, bridges, and many other possible teaching-learning projects in resource management.

Teachers thus far have conducted lectures, readings, movies, field trips, and displays as follow-ups in some of their classes. Responses by the students have included research papers, projects, and dioramas, not to mention personal recreation during free time.[2] Attempts have been made throughout the year to point out examples from the Garland Pond area when teaching specific subjects in biology, especially where conservation or ecology were concerned. The area, of course, also has provided specimens and examples for zoology and botany as well.

Materials used were, for the most part, already on hand except for extra tools purchased for this new part of the work job program. Axes, shovels, pruning saws, two rolls of barbed wire, and perhaps two hundred board feet of lumber have constituted the total materials used to date. It is presumed that some fertilizers will eventually need to be applied to the new pasture and that some

[1] An offshoot program included the pruning and cleaning up of some Red Pine plantations on neighboring tracts of school property by other students, including several former Garland Pond crew members. See fig. 4.

[2] Ibid.

further expense may be incurred while rebuilding Garland Pond, but equipment and supplies from the Putney School farm are expected to be available for these parts of the project.

Technical assistance and friendly advice have been given by several government agencies as well as by friends of the school. These include local and state offices of the U. S. Soil Conservation Service, the Agriculture Conservation Program advisor, the County Forester, and the local professional forester, plus numerous trustees and alumni. Also helpful have been suggestions from people connected with the Yale School of Conservation, the Conservation Foundation, Connecticut College Arboretum, New Hampshire Fish and Game Department, Society for Protection of New Hampshire Forests, the Vermont State Department of Education, and finally the University of Michigan School of Conservation, where the author obtained his Master's Degree.

Literature and publications have been available for teaching from materials collected over the years, mostly from government agencies and institutions of higher learning. A particular reference for local use, which has given the writer many ideas, has been a recent publication of the State Department of Education, Montpelier, Vermont, Curriculum Bulletin No. 8, *Conserving Natural Resources in Vermont*, for Grades 1-12, November, 1957. Of especial help also have been the U. S. Soil Conservation Service "Job Sheets" and "Conservation Information" sheets, mostly on wildlife plantings, for the Northeast Region. These have been an integral part of the official "Conservation Plan" drawn up by this federal agency for the Putney School Wildlife Area. Lastly, the *Handbook for Teaching of Conservation and Resource Use*,[3] has supplied numerous ideas of possible projects and techniques, in the classroom and out.

A few hints to keep in mind when attempting this sort of development might be helpful. Emphasis should be put on the *teaching* of proper resource use rather than on the actual *accomplishment* of physical changes. At Putney it was found too easy to stress the latter which made it difficult to get reasons involved across to all pupils. By occasionally asking a student why he was cutting down a tree or digging a hole, one could learn if real principles of conservation were being absorbed, or rather if just another job were being done.

Having learned "the hard way," this writer cannot emphasize too strongly the need for

FIG. 3. Putney students examine foot bridge and stream improvement dam built as individual projects during and after school "work periods" in newly created nature area.

FIG. 4. Students pruning Putney School Red Pine plantation crop trees to height of 17 feet as supplement to new outdoor education area programs.

[3]Richard L. Weaver, project leader. Interstate Press, Danville, Ill. 1955. 499 pgs. illustrated.

making a thorough photographic record of original conditions before any developmental work is begun. Of course, all subsequent operations and student achievements should also be put on film for comparison. Mapping is imperative too, and perhaps ought to be number one on the list, yet photos should probably be taken of this process as well. The sooner and more completely any sort of records are initiated, the more readily will effects of one's efforts, or lack of them, be noticed, and the more obvious will subtle ecological associations appear.

Another approach to consider when dealing with young people in resource development is the idea of *intensive* rather than *extensive* management. By conducting a variety of short term, easily completed projects on but one or two small areas of land, a leader can build interest most effectively and show actual results the soonest. Students appreciate variety and become bored only if kept at the same old task indefinitely. This may easily happen if one attempts to improve too wide a territory at a time, and it will usually result in poorer teaching. Interest can also be encouraged by letting students help in overall planning as well as the initiation and execution of their own individual or sub-group projects.

Lastly, nothing kills enthusiasm for nature study more quickly than being forced to take part in it against one's will. Those who elect to help out will usually grow and respond encouragingly if given proper guidance, stimulation, variety, and freedom to develop.

AIBS Visiting Lecturers Program

One of the services of AIBS in improving biology teaching is the Visiting Lecturers Program. Briefly, colleges and high schools may jointly sponsor or colleges may separately schedule one of the distinguished lecturers on the roster for a lecture to interested groups. The cost is quite nominal, and may even be without cost to the high school if a local college will initially sponsor the lecturer. Further information about this fine program may be obtained by writing Visiting Lecturers Program, AIBS, 2000 P Street, N.W., Washington 5, D. C.

The following scientists make up the roster:

Field	*Name and Title*	*Address*
ZOOLOGY	BODENSTEIN, DIETRICH	U. S. Public Health Service, National Heart Institute, Gerontology Branch, Baltimore City Hospital, Baltimore 24, Maryland
PLANT PHYSIOLOGY	BOGORAD, LAWRENCE	Department of Botany, University of Chicago, Chicago 37, Illinois
PLANT PHYSIOLOGY	BORTHWICK, H. A.	U. S. Department of Agriculture, Plant Industry Station, Beltsville, Maryland
HORTICULTURE	BOSWELL, VICTOR R.	U. S. Department of Agriculture, Plant Industry Station, Beltsville, Maryland
ZOOLOGY	BROWN, FRANK A., JR.	Department of Biological Sciences, Cresap Laboratory, Northwestern University, Evanston, Illinois
PHYSIOLOGY	BUCK, JOHN	Laboratory of Physical Biology, National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, Bethesda 14, Maryland
ZOOLOGY	BULLOCK, THEODORE H.	Department of Zoology, University of California, Berkeley 4, California
ANIMAL GENETICS	CHASE, HERMAN B.	Department of Biology, Brown University, Providence, Rhode Island
PHYSIOLOGY	DAVENPORT, HORACE W.	Physiology Laboratory, University of Michigan, Ann Arbor, Michigan
PLANT PHYSIOLOGY	GALSTON, ARTHUR W.	Department of Botany, Yale University, Josiah Willard Gibbs Research Lab., New Haven, Connecticut
PLANT PATHOLOGY	HAYDEN, EUGENE B.	Rust Prevention Association, 820 Midland Bank Building, Minneapolis 1, Minnesota
PLANT PATHOLOGY	HARRAR, J. G.	The Rockefeller Foundation, 49 West 49th Street, New York 20, New York
MEDICAL GENETICS	HERNDON, NASH	Department of Medical Genetics, Wake Forest College, The Bowman Gray School of Medicine, Winston-Salem, North Carolina
PLANT PATHOLOGY	HORSFALL, JAMES G.	Connecticut Agricultural Experiment Station, P. O. Box 1106, New Haven 4, Connecticut
BOTANY	HOWARD, RICHARD A.	The Arnold

Field	*Name and Title*	*Address*
	Arboretum, Harvard University, 22 Divinity Avenue, Cambridge, Massachusetts	
PLANT PATHOLOGY	JENSEN, J. H.,	Iowa State University of Agriculture and Mechanic Arts, Ames, Iowa
PLANT PATHOLOGY	KELMAN, ARTHUR,	Division of Biological Sciences, North Carolina State College, Raleigh, North Carolina
BIOLOGY, BIOCHEMISTRY	MCELROY, W. D.,	McCollum-Pratt Institute, Johns Hopkins University, Baltimore 18, Maryland
BOTANY, PLANT PATHOLOGY	MCNEW, GEORGE L.,	Boyce Thompson Institute for Plant Research, Yonkers, New York
BOTANY	PETRY, LOREN C.,	104 Devon Road, Ithaca, New York
BIOPHYSICS	POLLARD, ERNEST C.,	Biophysics Department, Yale University, Box 2166, Yale Station, New Haven 11, Connecticut
PHYSIOLOGY	REYNOLDS, S.R.M.,	Department of Anatomy, University of Illinois College of Medicine, 1853 West Polk Street, Chicago 12, Illinois
BIOLOGY	ROEDER, KENNETH D.,	Department of Biology, Tufts University, Medford 55, Massachusetts
BOTANY	SAX, KARL,	The Arnold Arboretum, Harvard University, Jamaica Plain 30, Massachusetts
PLANT PATHOLOGY	SHAY, J. R.,	Department of Botany and Plant Pathology, Purdue University, Lafayette, Indiana
PLANT PATHOLOGY	SNYDER, WILLIAM C.,	Department of Plant Pathology, University of California, College of Agriculture, Berkeley 4, California
PLANT PATHOLOGY	STAKMAN, E. C.,	Department of Plant Pathology and Botany, University of Minnesota, St. Paul 1, Minnesota
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A Search for Man's Sanity. Trigant Burrow, Oxford University Press, New York, 1958.

A collection of the letters of Dr. Trigant Burrow, a psychoanalyst more critical of psychoanalysis than most, who extended the methods of individual analysis to mutual analysis of members in a social group and to society itself. As a kindly patriarch, as a maverick psychoanalyst, and as the Scientific Director of the Lifwynn Foundation, Burrow carried on a wide and perceptive correspondence with members of his family, with friends and colleagues, with intellectual leaders in philosophy, the sciences, and the arts, and with cranks. His style in letter-writing is readable, his understanding and tolerance for the ideas of others is commendable and imitatable. His own ideas, while stimulating, are not satisfying. Like many moralists, Burrow was more concerned with a description of the configuration and meaning of maladjustment and conflict than with the discovery of determining conditions which must be manipulated in order to remedy them.

Douglass Ellson, *Indiana University*

Botany — Not Posy Picking

EDWIN B. KURTZ, JR.,

Department of Botany, College of Agriculture, University of Arizona, Tucson

Every high school biology course spends some time, albeit usually too short a time, on botany. Yet, I am afraid that what time is given to a discussion of plant life is quite often poorly used and most students are left with the impression that botany is just "posy picking." As a result the best students turn their interests to seemingly more colorful fields such as chemistry, physics, and electronics, and the average students are not even left with respect for plants as living organisms that face many of the same everyday problems as human beings and other animals.

One consequence of all this (the problem is compounded and not resolved in most college biology and botany courses) is that very few good students ever become interested in the plant sciences. This is most regrettable because many of the critical problems of today and in the future are botanical. Agriculture, forestry, feeding the world's pyramiding population, and even feeding future space travelers are all botanical fields and problems that need the highest calibre of human talent to study them.

Indeed, many of the scientists who are working at the frontiers of botanical science are not even botanists, but rather are persons trained in other fields and who recognize the intriguing and important problems that lie in the plant sciences. In the field of photosynthesis much of the current research is being led by Melvin Calvin, an organic chemist; Farrington Daniels, a physical chemist; and Otto Warburg, a biochemist. Much of the original work on plant growth hormones was done by Kögl and Haagen-Smit, both organic chemists. And the U. S. Department of Agriculture recently awarded a medal, which is given each year to the U.S.D.A. scientist who has made the most outstanding contribution to agricul-

ture, to Sterling Hendricks, a physical chemist who quite successfully studied seed germination and plant growth.

I have given high school and even college students a "cook's tour" of our botany research laboratories, and they are usually amazed to find that our laboratories look so much like what is found in the chemistry building. In fact, the standard question is: "Where are the plants?" In our research on fatty acid metabolism in plants, my students and I are using radioisotopes to trace the pathways by which long-chain fatty acids and fats are made from acetic acid, better known as vinegar. I have described the methods and techniques used in our studies to high school students and teachers, and the subject of botany has often taken on new meaning for them when they learned that our work involves a knowledge of a) how to grow plants in the greenhouse, b) how to grow plant tissues in petri dishes with radioactive substrates, c) methods of extraction, isolation, separation, degradation, and other chemical procedures for studying fatty acids and fats, d) the isolation and identification of fatty acids and their breakdown products by paper chromatography and gas chromatography, e) the use of radioisotope detection instruments such as Geiger counters, scalers, ratemeters, and monitors, f) the use of standard pieces of apparatus such as balances sensitive to one-hundreth of a milligram, pH meters, colorimeters, densitometers, culture chambers, and many others, and g) the calculations and statistics associated with interpreting the data. Thus botany, chemistry, physics, and mathematics all merge into one in solving a botanical problem.

Whether it be in the field of plant physiology, genetics, ecology, morphology, modern taxonomy, or any application of these fields, plant scientists in 1958 must know much more than just posy picking. In all fairness to the student, the field of botany should be presented to him in such a way that he realizes this. If he is exposed to botany in a less descriptive and more dynamic manner, he will not only gain greater insight into plant life, but he will also be better able to decide whether he will spend his life in some field of plant science. It is one thing to teach a student to be able to name all the parts and structures of a plant or to have him collect and press a number of flowers, but it is quite something else to have him think about why plant roots grow down instead of up; why a cell divides; how a plant makes sugar from carbon dioxide and water; why some plants flower only in winter and others flower only in summer; how a genetic character for red petal color brings about a red petal; how water gets to the top of a 200-ft. tree; why some plants grow only on the north side of hills; in what ways man is dependent upon plants for his very existence (there are more reasons than one would at first think, even when clothing, shelter, and fuels are not counted); in what ways (taxonomically, morphologically, physiologically, chemically, genetically) two closely related species of plants differ; how and why different wave lengths of radiation affect plants, and many others. If these problems are presented to him, including a discussion of how these problems are or have been studied by plant scientists, my guess is that everyone in the classroom, including the teacher, will find something that challenges his imagination and interest.

Books for Biologists

TEACHING HIGH SCHOOL SCIENCE: A BOOK OF METHODS, Paul F. Brandwein, Fletcher G. Watson, and Paul E. Blackwood, 568 pp., $6.50, Harcourt, Brace and Company, Inc., New York, 1958.

A substantial contribution to science teaching methods literature. Teachers whether in training or in service will want this cleverly written and highly organized volume. An extensive section of the book is devoted to teaching the scientific method and building up science concepts. The authors refer frequently to their own personal experiences in the classroom and to their own research. Quite vigorous stands are taken on most of the controversial issues in science teaching. In all, this is a stimulating and highly informative book which teachers will want as a handy reference.

WORKBOOK AND LABORATORY MANUAL IN GENERAL BIOLOGY, William C. Beaver, 251 pp., $3.75, C. V. Mosby Co., St. Louis, 1958.

Written to accompany the text by the same author. Emphasizes the recording of data and observations from which conclusions are to be drawn. Contains taxonomic chart for plants and animals. Valuable summary included for teachers which itemizes all supplies and equipment necessary for each exercise.

Teaching Evolution to High School Students*

JOAN HUNTER

Edwardsville High School, Edwardsville, Illinois

There are several considerations to be taken into account when teaching evolution, and I should like to mention these first.

First, I might say that the immaturity, inexperience, and limited knowledge of high school students makes the idea of evolution fascinating but difficult for them to grasp *in toto*.

Second, most students have looked to teachers as authorities in subject matter, and here is a field in which not even paleontologists or anthropologists are in complete agreement. This is emotionally confusing.

Third, most students have been brought up in a church with indoctrination into the idea of a single act of creation, and although their reasoning may accept the idea of gradual development, their emotions are often in conflict with this idea.

We must not try to refute the religious beliefs of our students. It is all right to point out what appear to be discrepancies or to ask questions which will point out discrepancies when the student answer the questions. This will help the students to think for himself after the facts are laid before him. However, we must remember that science and religion are both a search for truth. It is probably because of our limited knowledge in both fields that sometimes the two appear to be incompatible. We must also remember that no matter what our religious views, religion is a powerful force for good in the lives of people. It is especially strong in the lives of present day adolescents and although their views will change and stabilize as they grow older, they are very impressionable at this age, and we must not destroy their faith.

Fourth, I say that in our teaching we must be especially careful to approach this idea with an open mind and try to get our students to do the same thing. Family discussions outside the classroom may make this difficult at times, but on the whole, I have not found it insurmountable. My approach is usually to say, "Here are the scientific beliefs as to the origins of life; here are the facts to support those beliefs; there are missing links; but look at the facts for yourselves and see what you think. The facts are logical but, if when you finish your study, you cannot accept the theories based on these facts, just remember that it is of cultural value to you to know what other people of intelligence are thinking. Only by examining other points of view can we eventually arrive at the truth."

Before we can expect students to understand the basic theories of evolution, we must give them a background knowledge of proven facts. The essential topics which a student must have in mind in order to study evolution appear to be:

1. Knowledge of the classification of plants and animals on the basis of structure, principally the idea that similarities in structure put them in similar groups, and differences in structure subdivide the groups.
2. Enough comparative anatomy and physiology of plants and animals so they understand similarities and differences.
3. Enough embryology to show homology of selected organs.
4. Mechanics of heredity and an understanding of ratios involved in Mendel's laws.
5. Cause of mutations and their effects on future generations.
6. Some knowledge of the effects of environment on the structure and behavior of plants and animals.

From this knowledge the next step is into the study of changes which have taken place throughout the span of life on earth. This involves the study of the history of evolution. The work of Lamarck, Darwin, DeVries, Haldane, Wright, Fisher, Dart, Broom, Washburn and perhaps others can be described. For this background information, I recommend Ruth Moore's book *Man, Time, and*

*Presented at the Symposium, co-sponsored by NABT, at the annual meeting of the American Association for the Advancement of Science, December, 1957, Indianapolis.

Fossils (1943, Alfred Knopf, New York). This seems to be a good summary of the various ideas of evolution, is recent enough to include the more recent discoveries and the recent tools of discovery, as well as being written in language simple enough to be read by laymen and understood. Another such book dealing mostly with the evolution of man is *Man in Search of His Ancestors*, Andre Senet (1955, McGraw-Hill, New York).

From here it is but a step to the study of geology and fossils.

The study of all the changes gets to be quite complicated, and for this reason I believe that classroom lectures and discussions, accompanied by simplified charts, tables, specimens of fossils, and picture projections is the best means of teaching this material. Lectures are more desirable than reading because reading material is usually very involved and detailed, written in an unknown vocabulary, and often out of date. It is difficult enough for a teacher to sort the chaff from the grain without asking 14-15 year olds to do so.

Field trips to places showing stratification, variations in fossils, or present changes emphasize facts taught in the classroom. The Illinois Geological Survey conducts such trips in different parts of the state each year. This fall we accompanied them to strip mines, quarries, sink holes, river terraces, and cuts in limestone layers caused by rivers. The students were allowed to ask questions and to collect some of the fossils themselves. They were also given a pamphlet for identifying the fossils of Illinois. This can be obtained from the Illinois State Geological Survey, Urbana, for 25¢. Other states, no doubt, offer similar services.

Newspaper articles give evidence of present day changes in the earth's surface, and science magazines tell of changes in plants and animals brought about by experimental means. Students should be encouraged to be on the lookout for such articles and bring them to class. Descriptions of unusual animals and plants which might be considered "links" between taxonomical classes should be sought. Putting this to the class as a question "Is there an animal which shows the combination of traits peculiar to both amphibians and reptiles?" may help start them on their search.

Knowledge of these things of today lead to a discussion of the possibility of changes having taken place ages ago under circumstances which may have been more conducive to change.

A discussion, and possibly field trips, showing changes brought about in plants and animals of a locality when the environment changes is of value. It should be pointed out that plants or animals which have the ability to survive under changed environmental conditions grow and reproduce while others die. It should also be pointed out that this occurs in certain individuals of a species, not necessarily in the entire species. Instances of this are the survival of the flies exposed to DDT, and possibly, the survival of some elms which for some reason will be immune to the Dutch elm disease. Living proof of change makes the whole idea of evolution more plausible.

Lastly, in the study of the everchanging history of evolution we must deal with the methods used in arriving at the various conclusions. The use of sedimentary rock, of the presence of fluorine in bone, of radiocarbon dating, and of proof by experimental means should be discussed.

Before I conclude, I should like to say that the views expressed in this paper are not those of an evolutionist nor of a theologian but of a teacher very interested in better methods of teaching her students to seek the truth and of a student very anxious to learn whence cometh man and where goeth he.

Books for Biologists

MORPHOLOGY AND THE EVOLUTION OF MAN, J. J. Livingston, 133 pp., $3.00, Vantage Press, Inc., New York, 1958.

Random jottings from space to youth, but mostly about constitutional anthropology and psychology.

INTERMEDIATE HOSTS OF SCHISTOSOMA, G. Mandahl-Barth, 132 pp., $4.00, World Health Organization, Palais Des Nations, Geneva, 1958.

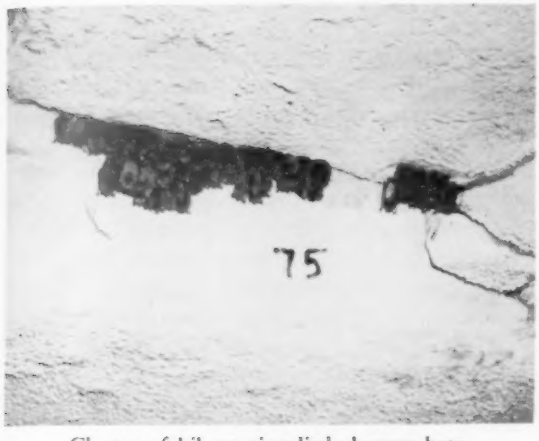
This is a well-illustrated, but highly technical, treatment of the African snails which harbor the intermediate stages of the human blood flukes. The classroom teacher will find it useful in illustrating the complexity of the life cycles of parasitic organisms and in stressing the need for precise morphological, anatomical, and taxonomic knowledge of apparently obscure organisms in disease control.

Frank N. Young, *Indiana University*.

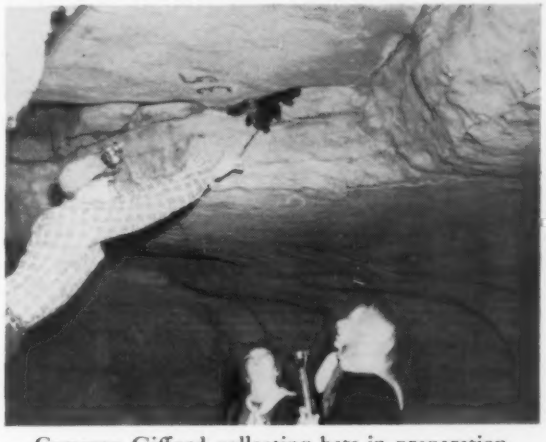
Notes on the Cave Fauna of Indiana*

RUSSELL E. MUMFORD

Department of Forestry and Conservation, Purdue University, Lafayette, Indiana



Cluster of hibernating little brown bats



Cameron Gifford collecting bats in preparation for banding.

Throughout the unglaciated region of south-central Indiana, wherever there are extensive limestone formations, are numerous caves. For the most part, they have been relatively little explored, mapped, or even counted, and to my knowledge no one today knows exactly how many are present. Their center of abundance is probably in Crawford and Harrison counties, in the vicinity of famed Big Wyandotte Cave. From Dubois County on the west to Jefferson County on the east, then northward from the Ohio River to Putnam County, are hundreds of underground passages, many as yet without a name. Caves come in varying sizes, shapes, amount of wetness, abundance of formations, and degree of danger. These dark, mysterious holes have long fascinated both the spelunker (cave explorer) and speleologist (cave scientist).

Caves have often figured in the folklore of our state; thus one finds in older writings reference to their utilization by Indians, moonshiners, outlaws, and wild animals. Wyandotte got its name from the Indians, some of which evidently lived in the cave, for they left remains of their occupancy. Outlaw Cave, in Orange County, is said to have been utilized by a band of renegades as a hideout. Several caves had the local name "Bear" Cave, and undoubtedly the black bear entered them for protection. Bear wallows, claw marks, and droppings have been reported from several southern Indiana caverns but the bear disappeared from Indiana about 1888. In the vicinity of Spring Mill State Park, near Mitchell, it is said that early settlers hung the carcasses of their butchered stock in the caves to keep the meat cool.

During the war of 1812, when there was need for calcium nitrate or "saltpeter" for gunpowder, the nitrous earth of Wyandotte and other caves was mined. Much of the nitrogen contained in this valuable product probably came from the droppings (guano) of bats. The earth was collected and soaked in vats and the dissolved saltpeter was recovered by evaporation. Remains of these vats were still visible in a small cave in Washington County in 1954, although they were no doubt last in use during the Civil War. Several caves in the state bear the name Saltpeter Cave; one is near Bloomington and another is near Wyandotte.

*Presented before the American Nature Study Society meeting with the AAAS in December, 1957 in Indianapolis. It has been published as Purdue University Agricultural Experiment Station Journal Paper No. 1341.

The photographs are through the courtesy of the Palladium-Item, Richmond, Indiana. They were taken by Gertrude L. Ward during a bat banding trip to Ray's Cave, Greene County, Indiana, February 7, 1953.

Invertebrates

Indiana's caves are rich in invertebrate fauna. One of the best papers on a single cave and its inhabitants is that published by Dr. A. M. Banta in 1907, which describes an intensive study of Mayfield's Cave, near Bloomington. He listed a total of 110 animals, of which 96 were invertebrates and 14 were vertebrates. Among the more interesting forms were amphipods, planaria, isopods, and the blind, white, cave crayfish. Various spiders abound in many areas, as do millipeds. Once I saw a milliped trapped in a cave spider's web. The interesting long-horned grasshopper (popularly known as "cave cricket") has been observed by the hundreds in shallow "rock houses" in Perry County, and they are commonly found in most caves over the state. Spider egg sacs often are covered with tiny beadlets of condensed moisture, which gives them the appearance of silvery pearls suspended from the ceiling. One observed on February 7 had evidently just hatched, for dozens of tiny spiders were crawling about it. Cave spiders spin elaborate webs, although they are sometimes inconspicuous until one looks closely at them.

Many insects utilize the caves as sites for winter hibernation, and some are present throughout the year. Blind cave beetles occur in some Harrison County caves and in others but are not easily discovered. Various species of moths, flies, and mosquitoes can often be located in number. One September morning I found a large, green dragonfly clinging to the cave ceiling not far inside the entrance, but this is the only one I have encountered in a cave.

A beautiful moth that is common in some localities is The Herald (*Scoliopterys libatrix*), a native of Europe, now widespread in this country. One that I marked in October remained in the identical spot on the cave wall for 92 days, then disappeared. Another in the same cave stayed motionless in one spot for 59 days. During this particular season, the first one entered the cave on September 6 and the last one was found March 31. At least one other, grayish species of moth spends the winter in our caves, but I have not identified it.

Many other species of insects are likely to be discovered in caves, as a check of Banta's list will reveal. Much remains to be learned concerning these forms.

Amphibians

Several salamanders and frogs enter caves, although in some cases these animals are no doubt washed into the caves by streams or runoff following heavy rains. Blind salamanders are known from caves in other regions, but have not yet been discovered in Indiana. The majority of our cave dwelling types are usually near the entrance, in the twilight zone, but occasionally one sees them much farther back. The most brilliantly colored species commonly encountered is the cave salamander (*Eurycea lucifuga*), which is a slender, pinkish-orange creature, with dark spots over the body and elongated tail. A Lawrence County cave which I had occasion to visit 76 times between August, 1954, and April, 1955, provided some information regarding the population and habits of this species. I found them present until November 9, then found no more until February 17. The highest number noticed on any one visit was 12 on August 25. The slimy salamander (*Plethodon glutinosus*) may be found near cave entrances or inside caves, where it sometimes lays its eggs. Little seems to have been written about other species of salamanders inhabiting our caves.

Many of the southern Indiana caverns have small streams flowing through them, thus creating suitable spots in which to find frogs. Just how long a frog can survive in total darkness I do not know, but I suspect that many of the animals we find have been accidentally swept into the underground passages. Leopard, pickerel, and green frogs are most commonly found, but the big bullfrog is also occasionally reported. Many probably fall prey to raccoon, mink, and other mammals that prowl along these streams at night searching for food.

Reptiles

I have never found a snake in an Indiana cave, although some forms might be expected to enter the cave mouth. They also no doubt occasionally fall into caves by accident. Some are known to eat bats and might be induced to enter in search of them. A ring-necked snake was captured on a mossy boulder at the entrance to Donnehue's Cave one August morning.

In Perry County I once found five dead box turtles which had evidently fallen into

a small cave near Derby.

Fish

Indiana caves are known far and wide for their blind fish (*Amblyopsis spelaeus*) and for the research conducted on this species in Spring Mill State Park caves by Dr. Carl Eigenmann. This noted scientist found that the female deposits its eggs in cavities in the gill pouches, where they are carried for a month. After hatching, young are carried another month before they are on their own. One can still see the remains of the cement pools near the entrance of Donaldson's Cave, where Eigenmann kept captive the fish he brought out of the caves for study. It is possible that another species of blind fish occurs in the state and future workers may locate it. Thomas Poulson, now of the University of Michigan, is currently studying the ecology of *Amblyopsis* in Indiana and other states. A number of "wet" caves in Indiana harbor these interesting animals, and they add a special attraction for cave visitors.

Other fish, including trout, have been planted in the cold streams which emerge from caves. Since some of these streams enter lakes, ponds and rivers, no doubt fish of various kinds find their way into our caves from time to time. The only species which I have seen very far inside a cave was a sculpin (*Cottus*) that Richard E. Phillips and I captured in Boone's Cave, Owen County, June 9, 1956, about 50 yards inside the cave mouth in the shallow stream.

Birds

I cannot remember a single Indiana cave which I have visited where I failed to find a phoebe's nest. This common flycatcher builds a bulky, moss-covered structure near the entrance, either on the side wall or on a shelf projecting from the ceiling. Here it is relatively safe from most predators and finds a beautifully sheltered site to raise its young. A group of us discovered one spring that the phoebe's nest served another purpose. At dusk we approached a small cave in Washington County, and I cautiously played the beam of my flashlight on a phoebe's nest. Thinking I saw something move in the nest, I examined it more closely and flushed three Carolina wrens from it. They had chosen to roost there, and a better spot I cannot imagine. At another cave, another Carolina wren was chased from a phoebe's nest at dusk.

James B. Cope placing band on a bat

Ted Chandik, naturalist at Spring Mill State Park in the summer of 1958, told me that rough-winged swallows nested in a narrow cleft in the ceiling of Donaldson's Cave. Owls could be expected to enter caves, both in search of bats and for shelter, but aside from very early reports from Wyandotte Cave, I know of no other records.

Mammals

Bats, sometimes by the thousands, are found in practically all of the caves over the state. The presence of caves enables these animals to spend the winter season successfully at this latitude. In November, large numbers of bats enter these retreats, though a few may be present at any month of the year, and remain relatively quiet until April. Some species, like the little pipistrel (*Pipistrellus subflavus*) hang singly and seem to remain in the same spot for months. Others, such as the little brown bat (*Myotis lucifugus*), the Indiana bat (*Myotis sodalis*), and the larger big brown bat (*Eptesicus fuscus*) move about more or less throughout the winter season. The latter three may be found in clusters, hanging in compact masses which may contain 500 or more. Such large groups are almost invariably formed by the Indiana bat, however, and its population is highest in Big Wyandotte Cave. Of the 12 species of bats known from Indiana, only one, the evening bat, *Nycticeius*, has not been found in caves. We see that this group of mammals is well represented in the cave fauna and composes one of the most striking portions of it.

James B. Cope, Earlham College, Nixon Wilson, Purdue University, and the writer

have been conducting bat banding studies in Indiana caves since November, 1951. During this period, we have placed small, numbered, aluminum bands on over 25,000 bats. The band is clamped loosely on one wing and enables us to learn much about the movements of these interesting animals from year to year. Other bat banders, both in Europe and the United States, are engaged in similar studies. In this country bat banding, like bird banding, is under the supervision of the Bureau of Sport Fisheries and Wildlife, U. S. Fish & Wildlife Service, Washington, D. C. Any bands recovered from these animals should be reported promptly to that agency.

The wood rat (*Neotoma*) is native to extreme southern Indiana and occupies caves and limestone outcrops along the Ohio River. One can usually determine its presence by finding large heaps of debris that the animal gathers and piles in conspicuous places. Such piles may contain bones, sticks, rocks, paper, metal, seeds, or any object imaginable which happens to catch the wood rat's fancy. Dr. Marcus Ward Lyon, Jr. once discovered a portion of the jaw bone of a white-tailed deer in such a midden, and this fragment proved to be from an extinct, Pleistocene species. Though now probably greatly restricted in range in Indiana, wood rats may formerly have occurred in several counties. They are gentle, curious, and tame animals that can be touched, or even captured, by hand in the wild. They may have been present in Wyandotte Cave, according to some early references, but no specimens were preserved. House cats entered the cave and evidently lived there for some time, taking a heavy toll of the fauna. It is said that they exterminated the wood rats. The cats also fed extensively on the bats, which they apparently knocked down in low passages as the bats flew past. In 1953 we noted dozens of bat wings littering the floor of such a passage in Wyandotte Cave and attributed their presence to the work of a cat.

We have been surprised to find the white-footed mouse (*Peromyscus*) far back in some caves. On the dusty floor, one can see a veritable mosaic of tracks and every bit of candy, chewing gum wrappers, or other foreign articles discarded by cave visitors bear tiny marks of mouse teeth. Their subsistence so far below ground must be rather hazardous, unless they are able to come above ground periodically for a more varied diet or sustain themselves on the invertebrate fauna.

Raccoons frequently travel long distances through caves following the underground streams. These waters furnish fish, frogs, crayfish, and other food items. Minks and opossums also enter the caves and often the overwhelming odor of skunk prevails, indicating a visit from this species. Walter Hahn once observed gray fox tracks in the snow leading into a cave at Spring Mill State Park. About cave entrances, woodchucks, chipmunks, and shrews find suitable areas for their burrows, or they live in the tumbled rocks lying about. These are cool retreats in summer, with considerable protection; thus it is little wonder that mammals make the most of it.

Dogs evidently enter caves, especially in company of man, as I learned one afternoon. I had gone to one of the Clifty Caves to band bats and near the cave mouth I noticed large dog-like tracks in the snow. While I was lighting my lantern, a St. Bernard appeared, and followed me into the cavern, his progress behind me being marked by frequent loud splashes and an occasional bark. As I stopped to examine a cluster of bats far inside the cave, my new-found companion ventured on and disappeared into the darkness. I soon forgot about the animal and retraced my steps back to the entrance. Before long, however, I heard barks, howls, and splashing sounds coming from the cave, then a prolonged period of howling, which indicated to me that the dog was lost. I re-entered the passage and guided my bulky follower to the outside.

Prehistoric mammal remains have been recovered from some caves and the bones of a peccary were removed from a small cave near Williams, Lawrence County. The discovery of the bones of an ancient white-tailed deer has already been mentioned. No doubt there are many fossils to be unearthed, but to obtain them will entail considerable searching and hard work. There would seem to be a good chance of finding such remains in the drier caverns which have chimney-like entrances from the surface. Animals often fall into such holes, from which there is no escape, and over the centuries their bones become deeply buried in the cave floor. Present day animals are also liable to such hazards, and more than once we have been momentarily excited over the skeletal remains of a dog, rabbit, cat, or raccoon.

What Causes the Holes in Swiss Cheese?

ROBERT C. GOSS

Loyola University, New Orleans, Louisiana

The making of cheese has long been an art of preserving milk or a method of producing special flavors or physical characteristics. The man who first attempted to make cheese is lost in antiquity. According to an ancient legend though, it was first made accidentally by an Arabian merchant. The merchant put his supply of milk into a pouch made of a sheep's stomach when he set out on a long day's journey across the desert. The rennet in the lining of the pouch combined with the heat of the sun and caused the milk to separate into curd and whey. He found at nightfall that the whey satisfied his thirst and the cheese (curd) satisfied his hunger and had a delightful flavor.

Today there are just 28 basic types of cheese. The flavor variations, however, total more than 400, each with its own claim to individuality. Accidental modifications or changes in one or more steps of the cheese making process throughout the centuries were largely responsible for the development of the different kinds of cheese.

Cheese is made wherever animals are milked. Most cheese is made from cow's milk, simply because cows are milked more generally throughout the world than other animals. Feta and Roquefort cheeses are made from the milk of goats and ewes respectively. Cheese is also made in some countries from the milk of other animals, such as camels (Krutt cheese), buffaloes (Latticini and Surati cheeses), and reindeer (Lapland cheese).

The ingredients necessary in making all kinds of cheese are milk and microorganisms; rennet, an enzyme preparation which aids in the curdling or coagulation of milk; and salt. Microorganisms have two functions in the making of cheese; (1) to make the milk acid, and (2) to aid in the ripening process. The microorganisms concerned with cheese making are the fungi and the bacteria.

No two cheeses are made by the same method. The details of setting the milk, cutting, stirring, heating, draining, pressing, and ripening the cheese are varied to produce characteristics and qualities peculiar to each kind of cheese. These methods attempt to favor the growth of the desired kinds of microorganisms in the proper order. If the wrong kind of sequences of organisms are active, abnormal cheese will result.

In the United States all cheeses are divided into two groups – natural and processed cheese. Most cheese is "natural" cheese; that is, it is made directly from milk or whey, in a few instances as opposed to process cheese which is made from a blend or combination of one or more kinds of natural cheese. Swiss cheese is a natural cheese.

Switzerland is famous for Swiss cheese, the so-called King of Cheeses. Swiss cheese is best known because of the holes or "eyes" that develop in the curd as the cheese ripens. The eyes often are ½ to 1 inch in diameter and from 1 to 3 inches apart. When the eyes have glossy interiors and are regularly formed they are supposed to denote Swiss cheese of good quality and flavor. A swiss cheese should be at least four months old to exhibit the desirable stage of ripeness. Ripening is the term applied to the changes which take place in flavor, body and appearance, when the cheese is held under specified conditions of temperature and humidity. Ripening is usually characterized by a softening or mellowing of the cheese with an increase in soluble nitrogenous compounds and a decrease in acidity.

Swiss cheese is called Emmentaler cheese in Switzerland because it originated in the Canton of Bern in the Emmental Valley about the middle of the 15th century. It was formerly believed that the atmosphere and grass in that mountainous region were essential to the development of the eyes. The first Swiss cheese in the United States was made about 1850 by Swiss immigrants, and much of it is still being made by their descendants. In the United States Swiss cheese is often called Schweizer or Sweitzer cheese.

Switzerland exports only the best grades of Swiss cheese into the United States. The cheeses are like massive wheels, six inches

thick and sometimes four feet in diameter, and weigh from 60 to 220 pounds.

Swiss cheese is now made in many other countries besides Switzerland, including France, Denmark, Germany, Italy, Finland, Russia, Argentina and the United States. In the United States about 50 million pounds of Swiss cheese are made each year in Wisconsin and Illinois, Idaho, Minnesota, Ohio, Utah and Wyoming. Approximately 2% of our annual milk production is used in the making of Swiss cheese.

In the United States we do not eat nearly as much cheese per capita as do people in some countries. We eat nearly twice as much now as 20 years ago, or about 10 pounds (all kinds) per capita per year. This increased consumption is the result, at least in part, of improvements made in recent years in the quality and uniformity of many kinds of cheese.

With increased scientific knowledge, especially since 1900, has come an understanding of the bacteriology and chemistry involved in the making of many cheeses. As a consequence, the art of cheese making has been transformed into a respected science. Prior to 1900, the practices of cheese making were closely associated with local conditions of climate, agriculture, and habits of the people. Today it is possible to control more precisely each step in the making process resulting in the manufacture of a more uniform product.

The characteristic holes of Swiss cheese are produced by the liberation of gases generated by bacterial action during the process of fermentation. Years ago scientific studies conducted by the Bureau of Dairy Industry of the United States Department of Agriculture demonstrated that good cheese of the Swiss type can be produced in America as well as other parts of the world by employing a bacteria "starter."

The chief function of the "starter" bacteria is to form lactic acid. The lactic acid coagulates the milk or hastens coagulation by rennet, favors expulsion of whey, and fusion of curd particles. It also protects the fermenting milk against gas and putrefaction, and favors the action of the pepsin and rennet during ripening. The pepsin added with the rennet plays an important part in the hydrolysis of proteins and mellowing of the cheese. Milk for most kinds of cheese must have a low bacterial count, so that cultures of the desired kind of organisms may be added as starters and not have too much competition from other types of microorganisms.

A "lactic starter" is used in the manufacture of Swiss cheese. The starter is made up of *Streptococcus thermophilus* and *Lactobacillus bulgaricus;* cultures similar to the ones used for butter. These particular organisms are utilized because they are able to grow at the high temperature (53° C.) at which the kettle is kept during the cooking of the curd. The lacto-bacillus and streptococcus produce lactic acid, which aids in expelling the whey, and they probably contribute to the breakdown of the curd during ripening.

In the ripening of Swiss cheese the propionic acid bacteria (*Propionibacterium shermanii*) are active. We know the particular genus and species of the various organisms used in cheese making, but cheese factories jealously guard the particular strains of bacteria used in their cheese. The Propionibacterium ferment the lactic acid present in the curd, converting it to propionic acid, acetic acid, and carbon dioxide. The holes of the cheese are produced by the accumulated carbon dioxide which causes minute explosions. Although the organisms that cause the gas holes are fairly well understood by scientists and may be introduced artificially, it is probable that the atmosphere and pasture of the particular region where the cheese is produced have a general influence upon the formation of the eyes. The characteristic sharp flavor is laregly attributable to the formation of propionic acid. The eye formation is controlled to some extent by regulating the temperature of the ripening room. This process can be formulated as follows:

$3C_3H_6O_3$	yields	$2C_3H_6O_2$	+	$C_2H_4O_2$	+	CO_2	+	HOH
Lactic acid		Propionic acid		Acetic acid		Carbon dioxide		water

Other microorganisms, usually not added as starter but present in the milk and in brine baths or on the shelves, aid in the ripening of the cheese and especially in the development of flavor. During the ripening period, the bacteria multiply at a fantastic rate. A half-inch piece of cheese may have as few as 100,000 bacteria when freshly made; 5,000,000 a few days later.

Selected Reference Works

Gebhardt, L. P. and Anderson, D. A. *Microbiology*. C. V. Mosby Co., St. Louis. 1954.

Hammer, B. W. *Dairy Bacteriology*. John Wiley & Sons, New York. 1948.

Sanders, G. P. Cheese Varieties and Descriptions. U.S.D.A. Handbook No. 54, Washington, D.C. December 1953.

Report of the Cooperative Committee on the Teaching of Science and Mathematics

BROTHER G. NICHOLAS, F.S.C. La Salle College
Philadelphia 41, Pennsylvania

The Spring Meeting of the AAAS Cooperative Committee on the Teaching of Science and Mathematics was held at the University of Texas in Austin. The Science Teaching Improvement Program (STIP) reported it has continued its earlier activities of participating with colleges, universities, academies of science and various scientific and professional organizations in an effort to improve the offerings in science and mathematics and to improve the teaching of these subjects in the schools. The four STIP centers at the University of Nebraska, University of Oregon, Pennsylvania State University, and University of Texas report that their activities in the cooperating high schools have produced gratifying results. At present an evaluation of the entire program is under way. Efforts are being made at each of the centers to secure local support for the work next year. To date, only the University of Texas has been successful in this regard.

The Mideast Regional State College Conference on Science and Mathematics was held in Washington, D. C., under the sponsorship of STIP. The purpose of the conference was to bring together representatives of the mathematics and science faculties of state colleges in order that they might have an opportunity to exchange ideas with others concerning current developments in science and in better teaching of science. A brief report was published in *Science* while a series of more extensive reports in *School Science and Mathematics* started with the June, 1958, issue.

During the academic year 1958-59 STIP is cooperating in a program to provide science instruction through open circuit television to the fifth and sixth grades of seven school systems in the Washington metropolitan area.

Preliminary conversations have been held with representatives of the Carnegie Corporation about a proposal for the extension of STIP for three more years. In the new proposal there are included a number of new items under the heading of educational experiments. Also requested are funds for a more comprehensive semi-annual News Letter and for several conferences each year. In the new proposal it is recommended that AAAS assure a responsibility for "balance" in the science curriculum. Some agency should assume the responsibility for providing balance among the sciences and level of instruction in elementary, secondary and college programs.

It was reported that the Traveling High School Library Program is to be quadrupled next year, with 800 schools participating. A comprehensive book list of science books for secondary school and community libraries has been ready for distribution since September, 1958.

The Subcommittee on Accreditation and Teacher Certification distributed a preliminary draft on "Recommendations for the Preparation of High School Teachers of Science and Mathematics." This report makes specific recommendations for each of the fields of science and mathematics taught in the schools. The section on biology was prepared by the National Association of Biology Teachers. Since the complete report of the subcommittee is scheduled for publication in *Science*, the recommendations on the preparation of biology teachers will not be presented here. However, 1,000 copies of the part of the report were distributed at the annual conference of the National Commission on Teacher Education and Professional Standards, held at Bowling Green, Ohio, June 24-28, 1958.

The Subcommittee on the Improvement of College Teaching discussed and recommended the following topics: (1) exchange of teaching personnel for a semester of academic year; (2) inter-institutional visits; (3) a special doctoral degree for college teaching; (4) competition for non-teaching assistantships rather than merely "handing out" such grants; (5) means of promoting wider acceptance of good teaching ability as a serious consideration for promotion in rank, and (6) how to hold good staff members against non-teaching offers. The subcommittee is now studying the nature of a recommended program for a special doctorate for college teachers.

The Subcommittee on Films recommended that a selected and annotated list of science films be prepared for distribution to science teachers. Also, it was recommended that suggestions for desirable new film productions be gathered and published.

The Subcommittee on Science in Junior Colleges made several observations in connection with the problem of staffing science departments in junior colleges. First, prestige is often more important than salary so far as recruitment for faculty positions is concerned. Second, junior college teachers require state certificates in only a few states and, third, the teaching load is usually high for junior college teachers.

Considerable time was devoted to a discussion of the need for a basic study of the role and purpose of secondary school courses in the sciences and mathematics and of the problems of articulation between high school and college courses in the sciences and mathematics. It was eventually proposed that the AAAS undertake this study.

Other matters discussed included a reported move in California to issue a general certificate which would allow a teacher to teach any general (academic) subject at any level—elementary, secondary, or junior college. A suggestion was made that the AAAS propose to NSF that a conference of the directors of summer institutes for elementary science supervisors be held to consider the content of these institutes. Another suggestion was made that a program of summer fellowships be instituted that would allow high school teachers to work on problems of their own, either along the lines of research or in the field of science teaching.

BIOLOGY IN THE NEWS

BROTHER H. CHARLES, F.S.C.

RAINBOW REALM OF TROPIC INSECTS, Lincoln Barnett, *Life*, November 3, 1958, pp. 54-70.

Another wonderful collection of color pictures of Darwin's World of Nature series. You will want at least two sets.

MIGRAINE, Dr. Walter C. Alvarez, *Good Housekeeping*, November 1958, pp. 18, 166-168.

Headaches are all too common. This article discusses factors which increase the severity of certain types of sick headache and what to do about them.

ALMOST EVERYBODY HATES BR'ER CROW, Rufus Jarman, *Saturday Evening Post*, November 1, 1958, pp. 28-29, 57-62.

Should crows be destroyed? This article furnishes much interesting information about crows. It should stimulate a lively discussion.

A HUNTER'S GREATEST PERIL, Paul Schubert, *Saturday Evening Post*, October 25, 1958, pp. 37, 95-98.

So-called sportsmen who shoot at almost anything which moves, spoil hunting for the rest of us. A good article to set off lively discussion on gun safety.

HOW TO BUY A HUNTING DOG, Herm David, *Outdoor Life*, November 1958, pp. 63-67, 102-106.

Want to buy a dog? Here's the straight dope on where to look and what to look for when choosing the dog that will be ideal for you.

DEER DO MAKE MISTAKES, Byron W. Dalrymple, *Sports Afield*, November 1958, pp. 40-43, 91-94.

A nontechnical discussion of the supposed and actual intelligence of deer and how we may outsmart them.

I LIVE WITH DEER, Francis E. Sell, *Outdoor Life*, November 1958, pp. 35-39, 91.

A careful observer with plenty of experience refutes several widely accepted beliefs about deer habits.

THE ANIMALS WE LIVE WITH, Rita Vandivert, *Saturday Evening Post*, October 18, 1958, pp. 38-39, 114-118.

What one photographer's wife learned about certain animals as her husband photographed them. What they raised in a city apartment may surprise you.

Key to the Identification of Acorns

RICHARD HEADSTROM
Canton High School, Canton, Massachusetts

Apart from their practical value as a source of food to our wildlife, acorns are of interest to the student of nature by serving to illustrate variation in fruit and as a means of identifying the different species of oak trees. To most of us an acorn is simply an acorn, and seemingly one acorn is much like another. Actually, these nuts are quite variable in shape and size, in the appearance of the cup, and in other features. These various characters have been used in setting up the following key for the convenience of those who may desire to identify the different species of oaks.

The oaks are divided into two groups: the white oak group and the black oak group. There are a number of structural differences that differentiate the members of these two groups, but the one with which we may be concerned is the fact that the acorns of the black oak group take two years to mature. Hence, any acorn found on the twigs of an oak during the winter or spring must obviously belong to the black oak group. However, it must be borne in mind that since the nuts are not mature the description of the nuts is not fully applicable and the determination must therefore be made essentially on cup characters.

KEY TO ACORNS

I. Shell of nut smooth inside; scales of cup more or less thickened at base giving a knobby appearance to surface of cup.

A. Cup cup-shaped.

a. Upper scales of cup with thread-like outgrowths forming a fringe to cup.

1. Cup: thick, hemispherical to top-shaped, enclosing from 1/3 to entire nut; scales pale woolly with pointed tips, tips of upper scales prolonged into more or less distinct fringe.
Nut: ovate to oval, 1/2 to 2 inches long; apex rounded or depressed; brown; covered with a pale down.
Kernel: white, sweet.
Nova Scotia to Manitoba, south to western Massachusetts, Kentucky and Texas.

Bur Oak
Mossy-cup Oak
(Quercus macrocarpa)

aa. Upper scales of cup not forming a distinct fringe to cup.

(1) Acorns long-stalked.

1. Cup: thick, enclosing about 1/3 of nut; scales pale woolly, tips at rim of cup enlongated, narrow, awn-pointed.
Nut: ovate to oblong, 1 to 1 1/2 inches long, apex covered with pale down, rounded or pointed; light chestnut.
Kernel: sweet, edible, ripe in October.
Southern Maine to Ontario, Minnesota and southward.

Swamp White Oak
(Quercus bicolor)

2. Cup: thin, with tapering base, enclosing 1/3 of nut; scales small, closely overlapping.
Nut: small, pointed, 1 inch long; very dark brown.
Kernel: not edible, ripe in October.
Along the coast from Virginia to Florida and Texas.

Live Oak
(Quercus virginiana)

(2). Acorns short-stalked or sessile.

1. Cup: somewhat shallow, enclosing 1/3 to 1/2 of nut; scales rather thin and flat, only slightly knobby, pale woolly; reddish brown.
Nut: ovate to oblong, 1/2 to 1 inch long, generally curved with pale down at apex; reddish brown, sometimes striped with darker brown.
Kernel: sweet.
Massachusetts to Iowa, Nebraska and southward.

Post Oak
(Quercus stellata)

2. Cup: thin, nearly enclosing nut; scales rugged, pointed.
Nut: flattened, broader than long, about 1 inch in diameter.
Kernel: not edible.
New Jersey to Indiana, Missouri and southward.

Overcup Oak
Swamp Post Oak
(Quercus lyrata)

3. Cup: flat-bottomed, lined with down, enclosing 1/3 of nut; scales appressed, hard, acute.
Nut: ovoid, pointed, twice as high as cup, 1 to 1 1/2 inches long; bright brown.
Kernel: sweet, edible, ripe in October.
Delaware to Missouri and southward.

Basket Oak

Cow Oak
(Quercus Michauxii)

4. Cup: thin, rather shallow, enclosing about 1/2 or less of nut; scales small, appressed, pale brown, woolly, the brownish tips of scales sometimes forming a slight fringe at rim of cup.
Nut: broadly ovate to oval, 1/2 to 1 inch long, narrow and rounded at pale, downy apex; light chestnut brown.
Kernel: sweet, edible.
Vermont to Delaware, along the mountains to northern Alabama, west to Minnesota, eastern Nebraska and Texas.

Yellow Oak
Chestnut Oak
Chinquapin Oak
(Quercus Muhlenbergii)

5. Cup: thin, deep, enclosing 1/2 or more of nut; scales loosely overlapping, pale woolly, red-tipped, thinner toward rim.
Nut: oval, shiny, apex blunt-pointed and covered with pale down, 1/2 to 3/4 inch long; light chestnut brown.
Kernel: sweet, edible, ripe in October.
New Hampshire to Minnesota and southward.

Dwarf Chinquapin Oak
(Quercus prinoides)

6. Cup: thick, deep, enclosing 1/3 or less of nut; scales hard, stout, reddish brown, woolly.
Nut: oval to ovate to nearly cylindrical, variable in size and relative thickness, 1 1/4 to 1 1/2 inches long; from three times to less than twice as long as broad; shiny; light chestnut brown.
Kernel: not sweet, scarcely edible, ripe in October.
Southern Maine to Ontario and southward.

Chestnut Oak
(Quercus Prinus)

B. Cup saucer-shaped, hemispherical.
b. Scales of cup white woolly.
1. Cup: shallow, thin, enclosing about 1/4 of nut; scales closely appressed with short, blunt tips becoming thinner and flatter at rim of cup.
Nut: ovoid to oblong, rounded at apex, shiny; 3/4 inch long; light chestnut brown.
Kernel: sweet, edible, ripe in September.
Southern Maine to Ontario, Minnesota and southward.

White Oak
(Quercus alba)

II. Shell of nut hairy inside; scales of cup broad and thin.
A. Cup cup-shaped, top-shaped.
a. Scales closely overlapping.
1. Cup: thin, constricted at base, enclosing 1/3 to 1/2 of nut; scales thin; light reddish brown; slightly downy; tips of scales at rim typically appressed against the nut.
Nut: oval to oblong, variable in shape; 1/2 to 1 inch long; light reddish brown; occasionally striate.
Kernel: pale yellow, slightly bitter, not edible, ripe in September and October.
Southern Maine to Ontario, Minnesota and Nebraska south to North Carolina and Illinois.

Scarlet Oak
(Quercus coccinea)

2. Cup: thick, more or less constricted at base, enclosing about 1/2 of nut; scales reddish brown, slightly downy, thin, tips or upper scales forming a fringe-like border to cup.
Nut: ovate to spherical, varying in shape; shiny; 1/2 inch long; light brown, generally more or less longitudinally striate.
Kernel: bitter, ripe in October-November.
New England to Ohio and Kentucky.

Bear Oak
Black Scrub Oak
(Quercus ilicifolia)

aa. Scales loosely overlapping.
1. Cup: thin, more or less constricted at base, enclosing 1/3 to 1/2 of nut; scales thin, light reddish brown, finely woolly, closely overlapping at base, loosely above, with free tips horizontally wrinkled and forming a loose more or less spreading fringe-like border to cup.
Nut: ovate-oblong, variable in shape, frequently coated with soft down, 1/2 to 1 inch long; light reddish brown.
Kernel: yellow, bitter, not edible, ripe in October.
Southern Maine to western Ontario and southward.

Black Oak
(Quercus velutina)

B. Cup saucer-shaped.
b. Scales closely overlapping.
1. Cup: flat, shallow, thick, rim somewhat constricted, enclosing about 1/5 of nut; scales thin, reddish brown, shining not at all or but slightly hairy.
Nut: ovate to cylindrical, with broad base and narrow, rounded apex; 3/4 to 1 1/4 inches long; dark chestnut

brown.
Kernel: pale yellow, white, slightly bitter, not edible.
Maine to Georgia and Tennessee, westward to Minnesota and Kansas.
Red Oak
(Quercus rubra)

2. Cup: thin, enclosing only base of nut; scales thin, slightly downy, ovate, light reddish brown, darkest along margin.
Nut: nearly hemispherical, wider than long and generally wider than cup; 1/2 inch long; light brown, often striate.
Kernel: pale yellow, slightly bitter, not edible, ripe in October.
Massachusetts to Virginia west to Kansas and Arkansas.
Pin Oak
Swamp Spanish Oak
(Quercus palustris)

3. Cup: thin, sometimes deep, often enclosing 1/2 nut; scales reddish brown, downy.
Nut: globular to oblong; 1/2 inch long; pale orange brown.
Kernel: bitter, not edible, ripe in October.
New Jersey to Florida and from southern Indiana to Missouri and Texas.
Spanish Oak
(Quercus falcata)

4. Cup: shallow, enclosing about 1/4 of nut; scales fine.
Nut: globular, 1/2 inch long.
Kernel: very bitter, ripe in October.
Delaware to the Gulf and from Kentucky and Missouri to Texas.
Water Oak
(Quercus nigra)

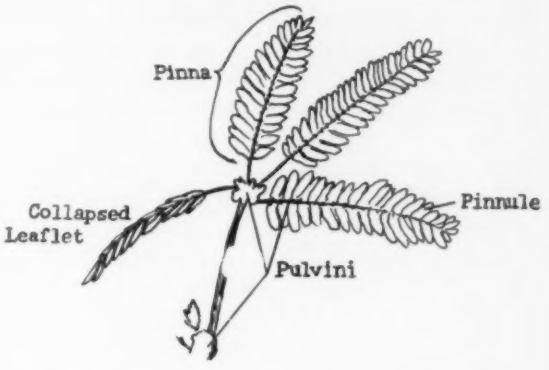
5. Cup: shallow, enclosing 1/2 to 1 1/3 of nut; scales light red brown, downy, rounded or acute at apex.
Nut: almost spherical, pointed; 1/2 to 2/3 inch long; reddish.
Kernel: very bitter, ripe in October.
Pennsylvania to Georgia, west to southern Wisconsin, eastern Nebraska and Arkansas; locally eastern Massachusetts.
Laurel Oak
Shingle Oak
(Quercus imbricaria)

6. Cup: shallow, enclosing base of nut only; scales dark reddish brown, thin, ovate, hairy.
Nut: half-sphere, downy, 1/2 inch in diameter; pale yellow brown, sometimes striate.
Kernel: Orange-yellow, very bitter, ripe in October.
Staten Island, New York to Florida, west to Kentucky, Missouri and Texas.
Willow Oak
(Quercus phellos)

The Sensitive Plant

THOMAS P. BENNETT

Florida State University, Tallahassee, Florida



One of the stranger members of the plant kingdom provides the resourceful biology teacher an excellent subject for some introduction to botany. The Sensitive Plant, as *Mimosa pudica* is often called, is a small herbaceous plant which grows wild along the coastal plains from Florida to Texas. The plant is characterized by a leaf which consists of from two to four leaflets, called pinnae, attached to the petiole. The pinnae are in turn made up of leaflets called pinnules. At the base of the pinnae and the pinnules are small swellings called pulvini. These structures are intimately associated with the response of the plant to stimuli.

The Sensitive Plant differs from most plants in that it has the ability to give a visible response to mechanical shock, electricity, temperature changes, chemical agents, light and other stimuli. The visible response consists of a number of distinct movements of the plant foliage. If the stimulus is not very great the pinnules bend toward the tip of the pinna and fold together. If the stimulus is increased the pinnules will fold together from the apex to the base of the pinna, then the leaflet may droop. If the stimulus is sufficiently strong its influence may be carried from the summit to the base of the plant. The visible response occurs approximately 0.075 second after stimula-

tion. The response is complete in a little more than than one second and recovery from the response occurs in eight to twenty minutes.

Early investigators believed that the Sensitive Plant possessed a nervous system analogous to that of an animal. This is no longer believed, but it is thought that the response involves a physio-chemical network. The center of the response mechanism is certain spongy tissue, the pulvini. When the end of the leaf receives a stimulus, the cells of the leaf and petiole transmit the stimulus and the pulvini bring about the visible response. The visible response is due to the excretion of water from the spongy tissue. This loss of water causes the pulvini to become flaccid, and thus, the structure, e.g., the petiole, which the pulvini have maintained in an erect position, is allowed to droop. When the stimulus is discontinued the cells of the pulvini reabsorb water and once again become rigid or turgid. This action completes the characteristic "visible response" cycle. These movements of water are known as turgor movements and the pulvini are special organs for varying turgidity.

The Sensitive Plant also gives a vivid demonstration of "sleep movements." The plant's foliage, which has been displayed in an expanded state during the day, begins to collapse when it becomes dark. The nocturnal position is very much as that which the plant assumes during the day when a suitable stimulus is applied.

There are many interesting experiments which can be made with the Sensitive Plant; e.g., the effect of light of different wave lengths on sleep movements, the effect of various chemical anesthetics on response time, the effect of temperature on response time, the determination of the threshold of response, etc. Experiments such as these require a minimum amount of equipment and provide an excellent series of experiments for the more interested student. As classroom demonstrations they vividly demonstrate the dynamism that pervades all life, plant as well as animal.

Note: *Mimosa pudica* seeds can be obtained from: General Biological Supply House, 8200 South Hoyne Ave., Chicago 20, Ill.

Books

PRINCIPLES OF RESEARCH IN BIOLOGY AND MEDICINE, Dwight J. Ingle, 123 pp., $4.75, J. B. Lippincott Company, Philadelphia, 1958.

A useful book to remind experienced researcher and student experimenter of the care and precautions which must be taken in biological research. Reviews the essential steps of the methods necessary for careful scientific experimentation and lists the assumptions, fallacies, and precautions involved. All this is presented in an easily readable form for both expert and novice.

TEACHING HIGH SCHOOL SCIENCE: A SOURCEBOOK FOR THE BIOLOGICAL SCIENCES, Evelyn Morholt, Paul F. Brandwein, and Alexander Joseph, 506 pp, $6.75, Harcourt, Brace and Company, New York, 1958.

This is in every sense of the word a "sourcebook" for the biological sciences. Only one section is devoted to a treatment of methods and classroom procedures. The great bulk of the book is a series of laboratory exercises and suggestions for the major units in biology. There is also an extensive bibliography of books, films, filmstrips, and other teaching aids. A detailed index makes this quite usable as a handy reference book. The illustrations are unusually good.

An unusually excellent pamphlet is available from the United States Department of Agriculture on plant regulating chemicals. Many experiments are described with full explanations for each. The pamphlet will be quite useful for high school as well as college teachers of biology. Students will find it an excellent source for innumerable projects. It may be ordered by writing the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. It is Agriculture Handbook No. 126, United States Department of Agriculture. The title is "Test Methods with Plant Regulating Chemicals," by John W. Mitchell, George A. Livingston, and Paul C. Marth. The price is 40 cents.

Planning Your Science Fair?

JOHN M. YOUNGPETER
Pontiac Central High School, Pontiac, Michigan

WHY HAVE A SCIENCE FAIR?

At the annual AAAS meetings held in Indianapolis, December, 1957, several of our leading scientists stated bluntly that America's lag in output of scientific research is not due to the fact that we are not spending enough money on research or that we lack adequate equipment. No, it appears to be a much more deeply-rooted problem than either of these. It is rather the type of science students which we are producing! Even many of the students in our outstanding research institutions lack the two primary qualities required by research –PATIENCE and CURIOSITY. Students are unwilling to spend the amount of time required to fully investigate questions which they may have. Further, they are too willing to accept all of the presently written materials unquestioningly.

With these unfortunate facts in mind, we in education must re-evaluate our approach, both from the student and instructional levels, and ask, "Where and how are we failing to stimulate the imagination possessed by children before they reach the age level when they may take scientific courses?" and "How can we develop greater patience and curiosity in, especially, those more talented in these fields?" It is clearly obvious that their social "graces" are not being neglected. Now we must turn our energies and attention to that job of training our students to meet these real requirements of successful living–primarily appreciating, wondering, and ultimately wanting to investigate the world in which we live, rather than taking all for granted.

If a student is willing to make himself become adequately interested in any problem to set up a public display and to do it in such a way that it is informative to all who view it, he, then, is developing toward this goal.

These are the benefits which a science fair can render: informing the public; stimulating the interest and imagination of the student; and contributing to the development of his patience and curiosity.

The Next Step

Having decided to attempt a science fair presents problems of housing the projects. This can be easily overcome by obtaining the use of the gymnasium, cafeteria, or science labs. Many times tables are available in the cafeteria or various classrooms which can be used for the display of the projects.

Every occasion such as this, especially when entrants are participating from outside your town school, will require a few rules to keep operations on par. These need be few and uninvolved. Below listed is the set of rules by which the Pontiac Science Fair successfully operates. Yours may be similar.

Science Fair Rules:

1. The Fair is open to all students in Oakland County schools regardless of grade level.
2. A student may enter not more than two projects.
3. No group projects will be accepted for judging, although they are invited to be displayed.
4. A registration fee of 25¢ per entrant will be charged.
5. Projects must be set up by 5:30 p.m. on Friday, March 14, and must be permitted to remain on display until 2:45 p.m. on Saturday, March 15.
6. Judging will begin on Friday at 6:00 p.m. Students are expected to be with their project at the time it is viewed by the judges if they expect to receive the most possible points which the project deserves.
7. The decisions of the judges will be final in all cases.
8. Projects should be so planned to include supports, etc., making it unnecessary for the project to be leaned or taped to the wall.
9. Projects must be removed from the gym by 3:30 p.m. on Saturday, or the Science Fair Committee will assume no responsibility.

10. Results of the judging will be made public on Saturday morning. Grand prizes will be announced at the presentation of awards.
11. REGISTRATION MUST BE COMPLETED BY NOON THURSDAY, MARCH 13, to assure the entrant of display space.

After these preliminaries, a certain amount of publicity is necessary not only in the schools affected, but in the community in general. The public will come to view such a show if they have the proper information. An attraction not to be overlooked is the obtaining of free or inexpensive science movies to be shown at a featured Science Theatre which can run simultaneously with the project displaying. It is well to keep in mind that movies should be obtained for all age levels and all science interests. It is wise to prepare a movie schedule (with running times, etc.) to be announced.

Project Planning

One of the major problems arising at this point will be suggestions for projects for those students who have not the imagination to find their own. It is a worthwhile expenditure of time during regular classes to ask each of your students to make a list of ten or more project titles. Then, a committee or the instructor can easily go through the lists, categorizing and organizing the titles into a list which can be duplicated or printed for general distribution. Following is a very short list of the type of titles which one will collect in this way.

MODELS—solar systems in clay, plastic, etc.; clay models of flowers, prehistoric animals, leaves; internal anatomy of animals; cells in 3-D; teeth; the eye; the atom; clouds of cotton.

CHARTS—on diseases; body functions, such as the digestive process; types of environments; adaptations of animal feet, teeth, skin, methods of protection, common birds or fish; the elements; atomic energy; community water supply or sanitation; soil and water controls; plant leaves; seed dispersal; life history of a guppy, elephant, a moss, etc.

COLLECTIONS—sea shells, leaves, insect, types of wood and uses, spices, types of tools and uses, rocks, seeds, skulls, foot prints, electrical switches, ropes, cloth, kinds of soils, etc.

EXPERIMENTS—growing plants, keeping aquaria or terraria; making water from gases; sound and its peculiarities; light, etc.

DEMONSTRATIONS—a working model of a volcano; a telegraph key; switches; animal learning experiments in mazes; comparing mixtures and compounds; proving theorems by 3-D; light and its relation to plants or animals; how bread rises; heart beats of animals by tape recording, etc.

These few suggestions are only offered to help your imagination get started.

Among other sources, of course, include the books on science projects published by Science Clubs of America (write: Science Clubs of America, 1719 N. Street, N.W., Washington 6, D. C., for *Sponsor Handbook*, project books, etc.).

After the project topic has been chosen, there are a number of things which the novice science fair entrant will benefit by following.

Points the students should keep in mind while planning, setting up and displaying the work are:

Keep the judging criteria in mind as you do your display, but always keep in mind the most important part of it is what YOU gain in increased knowledge, interest, and experience.

Use your imagination to organize a clever and unique display. Make it eye-catching, if possible.

Use all sources, books, pamphlets, etc., to become acquainted with your subject.

Be certain that your project follows the subject chosen and is well developed . . . not too much, not too little.

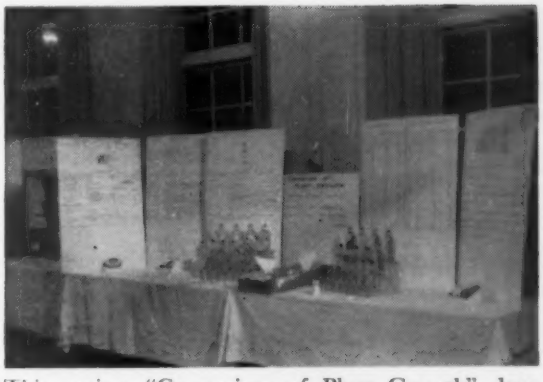
It should tell the "story" indicated by the title.

Will it tell someone who knows NOTHING about your subject something?

Take all the tools, tape, extension cords, etc., which your display will require. Remember—it is YOUR project, not that of the Science Fair Committee.

After working hard on a good display, the student must take all precautions when preparing to transport it to the place of display. Careless planning in packaging of delicate and breakable parts can ruin months of work. Usually, even the larger projects can be efficiently and concisely packed, if enough time

This project which was on display at the 1957 AAAS meeting, is the work of Ronald Hoekman of Pontiac. It is entitled "Evolution of the Vertebrate Heart" and illustrates well how a project can instruct those who know little about the theme. Here Ronald uses well prepared posters of explanation to unify the clay models which show internal and external structure and the actual specimens. This is all mounted on a plywood blackboard. (Photo by Bob Tenny)



This project "Comparison of Plant Growth" done by Richard Serwin of Pontiac required 8 feet of display space; yet it was compactly fitted into few selected cartons. With this proper packing none of the many bottles or plants were damaged or broken while transporting the display to Indianapolis for the AAAS meeting in December, 1957. (Photo by Bob Tenny)

and planning is given to this phase.

For the sake of organization and judging, it is advisable to plan various divisions in the set-up of the fair. At the outset, one need include only; elementary science, general science (grades 7-8-9), biology, chemistry, physics.

The judges and viewers will be aided if the registration ticket with the project tells them the age, grade level, and science course work of the entrant.

Ribbons should be sufficient award for the rating, except for grand prizes in the various divisions. A grand prize is awarded at Pontiac only in those divisions in which the judges feel one project is especially outstanding. Then, the winner is given his choice of a reference book in the major field of his interest. The financing of the book awards, if not possible through the school, may be undertaken as a project of a local Kiwanis, Rotary or Medical Society.

By giving reference book awards, properly inscribed to the winner, emphasis, is placed on the excellence of academic achievement.

By providing those winners with these references, they will be able to further develop their interest, furthering one of the purposes of a science fair.

New Drugs

A new champion is hopefully being primed to meet the challenge of the dreaded Staphylococcus—now roaming at large in many hospitals where it has become resistant to antibiotics. The hope is based on the synthesis of a new class of compounds called sulfonyl hydrazones, according to a report by Dr. Benjamin H. Gross, research chemist of Chattem Chemicals, Chattanooga, Tenn. Some compounds of this series have been shown in laboratory tests to be more deadly toward Staphylococcus and Streptococcus bacteria than the well known sulfa drugs, Dr. Gross said.

Investigation has shown that the new drugs act on the bacteria in a way entirely different from that of the sulfa drugs, and this discovery supports the idea that they may kill bacteria which have become resistant to the sulfas, he asserted.

Following the discovery of sulfanilamide in 1934, research chemists began in intensive effort to develop new variations of the sulfa drugs for use against the great number of bacterial infections, the speaker commented.

It was soon found that the synthesis of drug variations enables physicians to keep only a step ahead of the bacteria, which often have the disconcerting ability to develop resistant forms, immune to the effect of the new compounds, he explained.

"These bacteria include the familiar menace Streptococcus as well as the Staphylococcus, which has received so much publicity recently following the discovery that it often develops resistance to the antibiotics.

Some Information About the Biology Applicants for NSF Institutes at the University of North Carolina

VICTOR A. GREULACH

Co-Director, NSF Summer Institute, University of North Carolina

A few facts about the training, teaching assignments and characteristics of teachers who applied for work in biology in the 1957-58 Academic Year Institute and the 1958 Summer Institute at the University of North Carolina may help characterize the type of teacher desiring Institute training.*

The number of applicants for biology training was 141 in the Academic Year and 183 in the Summer, and 17 and 25, respectively, were granted stipends. The summer applicants consisted of 117 biology teachers and 66 general science teachers, 30 of the biology teachers being assigned to biology only. The Academic Year applicants included 24 general science teachers and 117 biology teachers, 19 of them teaching biology only. The Summer applicants had a mean age of 39.8 years and a mean of 11.5 years teaching experience, while the comparable figures for the Year applicants were 33.9 and 5.3, respectively. While 44% of the Summer applicants had a masters degree, only 12% of the Academic Year applicants had secured this degree. Only 26% of the masters degrees held by Summer applicants were in biological fields, the remainder of the degrees being largely in education, the comparable figure for winter applicants being 29%.

Table I lists the mean number of courses (both under-graduate and graduate) which had been taken by applicants for the Institutes. The generally poorer training in botany than in zoology is evident, as is the extensiveness of course work in education. Only 2% of the biology teachers applying for the Academic Year Institute and none of those applying for the Summer Institute completely lacked college courses in biology. About 21% of the Academic Year applicants and 14% of the Summer applicants had taken over 10 biology courses. Some 10% of the Summer applicants and 20% of the Year applicants who were teaching biology had taken no botany courses, the figures for general science teachers being 30% and 24%, respectively.

Of the biology teachers applying for the Summer Institute, 43% had an undergraduate major in biology, 2% each in botany or zoology, 32% in other sciences or science in general, and 21% in other fields than science (including 6% in education).

The Summer applicants belonged to an average of 2.0 education societies and 1.2 scientific or science education societies, and read an average of 1.3 educational periodicals and 2.3 scientific periodicals, but the years applicants read an average of only 1.3 scientific periodicals as compared with 1.9 education periodicals. However, among the Summer applicants 53% had no scientific or science education society memberships, and 30% read no scientific periodicals, the membership and reading percentages being brought up by relatively high figures for a rather small number of the applicants.

The journals read by the Year applicants were tabulated and the per cent of the group reading various scientific periodicals are tabulated in Table II. It is evident that no single journal reached a substantial per cent of the applicants and that few read any of the scientific research journals. There was no indication as to the extent to which any periodical was read and digested.

In selecting participants from among the applicants the University of North Carolina Institutes followed what is perhaps the most common Institute practice throughout the country; i.e., an effort being made to select

*This information was secured from the NSF Institute application forms. The complete report, including detailed tabular data, is available without cost from the Institute of Natural Science, Venable Hall, University of North Carolina, Chapel Hill.

TABLE I. Average Numbers of Courses Taken by Applicants for the Biology Program at the University of North Carolina Institutes.

Field	Biology Teachers		General Science Teachers	
	Summer	Year	Summer	Year
Biology	7.1	7.7	4.7	7.8
Botany	(1.8)	(2.0)	(1.2)	(2.5)
Zoology	(3.5)	(3.5)	(2.1)	(3.4)
General	(1.8)	(2.2)	(1.4)	(1.9)
Chemistry	2.2	——	1.8	——
Physics	1.2	——	1.0	——
Total Science	10.5	——	7.5	——
Education	10.0	——	11.4	——

TABLE II. Per Cent of Academic Year Institute Applicants Reading Various Scientific Periodicals.

Scientific American	15
Science Teacher	15
Science News Letter	13
Nature Magazine	7
American Biology Teacher	7
School Science and Mathematics	7
Science Digest	5
Journal of the American Medical Assoc.	3
Science	2
Biology Research Journals	2
Miscellaneous scientific or semi-scientific periodicals read by less than 2% each	24

teachers who seemed capable of doing good quality work but who were deficient in knowledge of the subjects they were teaching. Preference was generally given to those who had been teaching at least three years but who still had a substantial portion of their career ahead of them. Despite the difficulty of judging capability from the data available, and though most participants proved to have even less biological knowledge than would be presumed from their course backgrounds, the great majority have been eager and hard working students and their rate of progress has been exceptional. There seems to be little doubt but that the NSF Institute Program is contributing greatly to the subject matter competence of secondary school science teachers.

PREHISTORIC MEN, Robert J. Braidwood, 187 pp., $1.25, Chicago Natural History Museum, Chicago, Ill., 1957.

The changing world of the prehistoric man, the men themselves, the beginnings of culture, the early moderns, the first revolution, the conquest of civilization and the end of prehistory—all are presented in a pleasing manner.

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Compiled by John D. Woolever
Riverview High School, Sarasota, Florida

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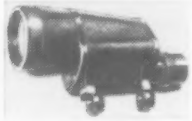

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There is evidence that radioactive fallout materials may be concentrated in some bones of elderly people to a greater extent than previously supposed. This possibility has been supported in part by a limited amount of data on the concentration of strontium-90 in the bones of persons 70 to 80 years old, these persons having a seemingly higher concentration of strontium-90 than the average adult of the 40 through 60-year-old group.

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December 1958

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